Alberta Environment
Regional Services

Controlling

SHORELINE EROSION

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CONTROLLING SHORELINE EROSION

A Property Owner's Guide to Lake Shore Erosion Protection Methods
These notes present information on ways to control shoreline erosion and are intended as general information to assist the public when considering such work.

Alberta Environment presents this information as a public service. While all of these methods have been used to control erosion problems, no erosion control technique will ever be completely successful in all applications. There is no guarantee that a particular method will be successful. This is especially true for low cost, "do-it-yourself" projects. This compilation includes a description of protection methods, their advantages and disadvantages. Substantial cost savings may be realized if you have the necessary equipment and can do much of the work yourself or know someone who can do it for you. A section on winter ice processes has been included.

DISCLAIMER...This information is based on the data currently available. Although every effort has been made to ensure the accuracy, currency and reliability of the content, Alberta Environment accepts no responsibility or liability for the accuracy of the designs or cost estimates provided. Alberta Environment shall have no liability or be responsibly for any damages that flow from reliance on the information presented herein. Any user of the information with or without the knowledge of Alberta Environment relies on the information at their own risk. The users of this data are advised to seek professional advice from a qualified professional in this field. The users of this data must satisfy themselves as to the awareness of the risks involved and the appropriate mitigative measures, which should be taken with respect to any proposed activity. These designs and costs are intended as a guideline only.

BROKEN WEB LINKS
Every effort is made to maintain the links to other web sites. The majority of the links are to other government information WebPages.

LEGISLATION

Provincial
Provincial legislation, specifically The Water Act (Alberta) requires that **anyone planning to modify the bed or banks of any body of water must obtain an approval from Alberta Environment prior to proceeding with the work.** Controlling shoreline erosion is subject to the requirements of the Water Act legislation and the Public Lands Act. An application and regional contacts may be obtained from the Department's website at:
http://www.gov.ab.ca/env/water/legislation/index.html. More details are in **Appendix 1**

Federal
Authorizations will also be required under the Fisheries Act and Navigable waters Protection Act. Both legislative Acts are Federal documents and are administered by **Fisheries & Oceans, Canada.**
Information regarding the Federal Fisheries Act and may be obtained from their website at:
http://www.ncr.dfo.ca/habitat/Law_Reg/english/index_e.htm

Contact information may be obtained about the Federal Navigable Waters Protection Act at:
http://www.ccg-gcc.gc.ca/cen-arc/nwp-pen/client_e.htm

Other
Approval from the local authority (City, Town, Village, County, Summer Village etc.) is also required.

Authorizations from all three regulatory institutions **are required.**

Great care must be taken by the applicant and their contractor to avoid Harmful Alteration, Disruption or Destruction of Fish Habitat (HADD) as specified by the Federal Department of Fisheries & Oceans at the above website. This means unauthorized harmful alteration, disruption or destruction of fish habitat by any means. This includes any changes to the band or bed of any water body. Early and personal contact with the Department of Fisheries and Oceans, Canada is suggested for advice in this matter.

If you plan to carry out any work that will place material in or on the shoreline of any river or lake, initial **consultations** with the Alberta Government **are strongly recommended regardless of the perceived ownership of that land**. These consultations are with the Department of Sustainable Resources Development, Public Lands Division. The ownership of the land must be clearly established by all concerned prior to any plans formulated. The regional office locations for such consultation may be found at:
http://www2.gov.ab.ca/home/Programs_and_Services/dsp_PS.cfm?PS=8201

A bound copy of The Water Act (Alberta) may be obtained from the **Queen's Printer** at:
10611 - 98 Avenue J.J. Bowlen Bldg. Room 204
Edmonton, T5K 2P7 620 - 7th Avenue SW Calgary, T2P OY8 1
Ordered on the web at: **http://www.gov.ab.ca/qp**
Print or view the 106 page document at: **http://ww.gov.ab.ca/qp/ascii/Acts/WPD/W03P5.TXT**

BE PRO-ACTIVE: PREVENT EROSION PROBLEMS BEFORE THEY OCCUR

The risk of shoreline erosion may be minimized before a problem develops by:

1. Keep additional weight away from the shore. Adding weight near a shoreline weakens the ground and may cause it to break away and slip into the water.
2. Control pedestrian and vehicle traffic so that access to the water occurs only at specific, stable locations. This is particularly applicable to cattle and other livestock. A fenced lane 15 metres wide (50') will permit watering access while protecting the bank and all vegetation.
3. Diverting surface runoff or drainage away from areas where shoreline erosion may become a problem. Installing a culvert or small drop structure dissipates energy and protects the shoreline where diverted runoff will enter the water body.
4. Installing subsurface drains where water is observed seeping from the bank. Subsoil moisture or groundwater seepage may loosen and carry away the soil.
5. Maintain all vegetation in a healthy state and avoid removing any vegetation along the shoreline where possible.
6. Discourage beaver predation of trees by wrapping the vulnerable trees with wire mesh, up to at least 1 metre (3') above the ground

BEFORE YOU START...

Trial and error solutions to erosion problems may eventually work, but can be very costly, frustrating, and time-consuming process. Here are a few basic concepts to consider before starting your project:

1. Try to identify exactly what changes have occurred along the shoreline over the past few years. Discussions with neighbors or long time residents may be useful. Old pictures or airphotos may assist in determining the location and rate of bank erosion. This may help in trying to predict future shore movement and problems.
2. Is the project you're planning likely to cause new problems? Will the plans you have made be adequate? Protecting the shoreline often requires a considerable effort, often with very large and durable materials. At this point, professional assistance may be needed for initial advice or recommendations. You are about to embark on a complicated and probably very expensive repair. Make sure you are up to the task.
3. Make the necessary provisions for routine maintenance of your project. This may mean having certain materials readily available. Easy vehicular access may be required for larger equipment. Inspect your project regularly and undertake repairs right away.

REPAIRING SHORELINE EROSION

These notes contain information on several methods recommended for use on Alberta lakes. The method you select will likely depend to a great extent on the resources available to you (money, construction materials, experience, available equipment and time). Advice from a Professional Engineer and/or Professional Biologist is strongly recommended.

The level of protection achieved will largely depend upon the method you select. In general, the more expensive the project, the more dependable and maintenance free it will be, if properly constructed.

Four methods of repairing shoreline erosion, which have had success in Alberta are:

1. **Reshaping the mildly eroding bank;**
2. **Vegetating the sloped bank;**
3. **Protecting the shoreline with armour material; and**
4. **Re-establishing a washed out shoreline.**

Other methods of controlling shoreline erosion that may be used are used-tire breakwaters, gabion baskets and timber retaining walls. These designs suitable as very ambitious do-it-yourself projects. However, these schemes are more complex and require the advice of a Professional Engineer and/or Fish Biologist.

The information contained herein includes a description of the protection method, its advantages and disadvantages. Where possible approximate estimates of the associated costs (in 2001 Canadian dollars) is provided to hire a contractor to do the work. These costs are approximate and can be expected to vary depending upon your location, availability of materials and the actual size of the project. Some cost savings may be realized if you have the equipment and can do the work yourself. Please remember these designs and costs are generalized and intended only as a guideline.

A WORD ABOUT MEASUREMENT UNITS

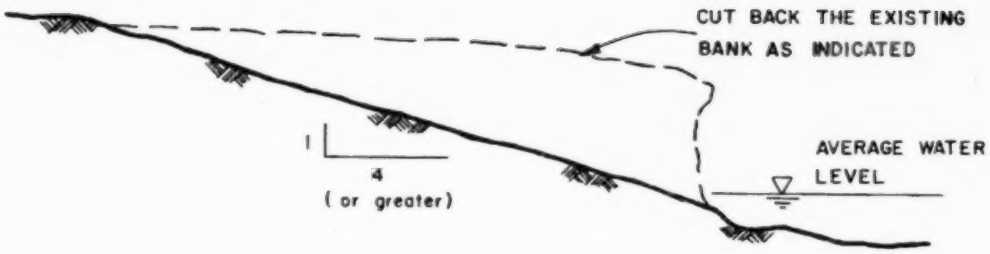
Throughout this brochure, the Metric system of units is used. For convenience the equivalent dimension in English units is provided as well. For further reference, the following conversion information is provided:

1 metre (m) = 100 centimetres (cm) = 3.3 feet (ft) = 39.4 inches (in)

METHOD 1
RESHAPING THE MILDLY ERODING BANK

In cases where the shore is relatively stable and the erosion problem is not severe, reducing the bank to a more gradual slope means the removal of material that would otherwise have been eroded. This is the least expensive method of controlling shoreline erosion, costing roughly $225.00 per lineal metre length of bank ($75.00 per foot). The preparation of the shoreline would cost about $75 per lineal metre ($25 per foot) of shoreline, while the protection of the toe would cost about $150 or more per lineal metre or $50 per foot. You can expect frequent maintenance requirements, especially after a major storm or runoff event.

The more gradual the slope, the less material is available to erode and the more stable the bank will be. While there are no guarantees with nature, a slope of four metres of horizontal distance for each metre of vertical drop (a four to one slope) is recommended. To construct this new slope, it is much easier to cut back the existing bank, rather than to build outward using fill. A slope made of fill is more easily eroded than one that is cut into the native stable soil.



METHOD 2
VEGETATING THE SLOPED BANK

The construction procedure consists of three parts. **First**, the shoreline bank must be reshaped to a more gradual slope. In this case it is recommended that it be cut back to a 3:1 to one slope, or flatter. **Second**, the toe of the slope must be protected. **Finally**, vegetation must be established and watered frequently for several months until the growth catches.

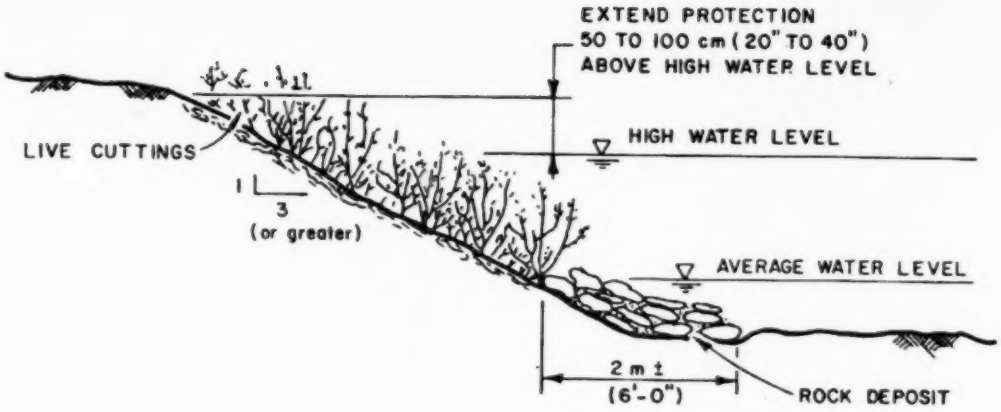
Once the bank has been sloped, similar to Method 1, it should be covered with an erosion resistant material, such as vegetation, matting, boulders or angular rock because a bare slope is more susceptible to additional erosion. Establishing grasses, shrubs and/or trees on the bank will enhance long-term stability.

The additional cost of establishing vegetation on the shore is difficult to quantify, as most of the expenditure would be for labour and watering. Once the vegetation becomes strongly established, the protection should be relatively maintenance free if erosive forces remain very low. It is strongly recommended to resist trimming shoreline vegetation or grasses at any time.

Protecting the Toe of the Slope

The toe of the slope is the part of the shoreline that is submerged during most of the growing season and will tend to deepen (scour) due to recurring storms or wave action. Generally this area will not sustain a protective vegetative cover. However, protection of the slope below the waterline is the main key to successful stabilization, because it prevents further scour and undermining of the bank. When the toe of the shoreline is stabilized, wave action can no longer carry soil away from the base, undercutting is stopped and eventually the slope reaches a state of equilibrium where slumps and slides no longer occur. As soil movement ceases, vegetation becomes firmly established, helping to hold the soil in place.

To protect the bottom area, place large rock along the toe of the slope. Armour rocks may be grouped into size classifications as indicated below. The size of rock required depends on the height and strength of the waves and degree of erosion occurring. Ideally these rocks should be very angular. The size of rock will depend on the height of the waves and degree of erosion occurring with at least Class 2 size (see below) required in most sites. To protect this bottom area, the rock layer should be at least two layers thick (twice the mean rock diameter) and extend out onto the lake bed at least one to two metres (three to six feet). If it is not done, the shoreline protection work will almost certainly fail.



CLASSIFICATION OF ARMOUR ROCK SIZES
Class 1 rock... 20 to 45 cm (8" to 18") or 10kg. to 130kg. (25# to 300#)
Class 2 rock... 30 to 80 cm (12" to 30") or 40kg. to 700kg. (80# to 1500#)
Class 3 rock... 50 to 1200 cm (20" to 48") or 200kg. to 2400kg. (4000# to 5200#)

If only small (4" to 8" rounded) rock is available, gabion baskets are an excellent choice. However their life span in Alberta is limited to 10 years or less on a lake shore due to ice breaking the woven wire mesh during spring break up. Where gabions are not subject to ice shove or abrasive action of a flowing current, they function well. Further information about gabions and their applications is available at **http://www.maccaferri-canada.com**.

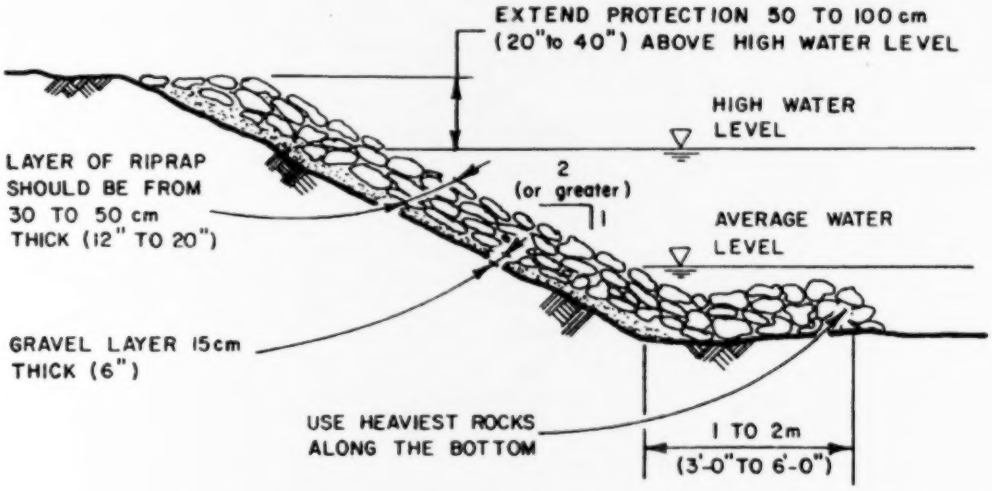
Broken concrete is another possibility (if the pieces are large enough) but only if all of the protruding reinforcing steel (rebar) and debris (waste construction material, silts, small gravels) is removed prior to installation. Smooth rounded fieldstone or rounded stones found in or near a lake shore, regardless of size are not recommended due to their ability to roll and slide in wave action.

Establishing Vegetation on Top of the Bank
Grasses should be established where trees and shrubs are considered undesirable. In all other cases, trees and shrubs are preferable as their spreading root systems stabilize the soil, offering greater protection. A more complete discussion of planting and maintaining vegetation at the shoreline is presented in **Appendix 2**.

METHOD 3
PROTECTING THE SHORELINE WITH ARMOUR MATERIAL

In cases where the attack along a shoreline is severe, armouring the entire slope will provide superior bank protection. This bank protection consists of placing 2 layers of rock (or equivalent material) on a sloped bank, similar to Method 2. This method of bank protection must have a filter (gravel or cloth) between the rocks and the prepared slope to keep the fine materials from leaching from the bank into the water body. This type of protection has a rough, natural appearance and adjusts itself to the shape of the shoreline.

First, the bank is reshaped to a 3 to 1 slope. Then a filter is placed on the sloped bank. This filter can be either a filter cloth or a layer of coarse gravel at least 20 centimetres (eight inches) thick. Without a filter, fine-grained material making up the bank will erode through the armour layer, causing the armour layer to collapse and fail. Finally armour rock with a Class II gradation is placed on the filter, and extended into the water body, as in Method 2. To complete the work, both ends of the bank protection should be turned inward into the bank and extended about 2 metres (6 feet) into the bank, for the full height of the protection. This "keying" into the bank will prevent the risk of erosive forces outflanking the protected bank. For narrow lake lots, the cost of this protection can be a substantial proportion of the total cost. Co-operative action with adjacent landowners would eliminate the need for "keying in" at every property line.



The approximate cost of grading the bank to a two or three to one slope would be about $50 per lineal metre along the bank or $15 per foot. The additional cost of the filter layer would be approximately $50 per metre or $15 per foot of bank. The cost of the armour material itself would depend upon the type of material used. As an indication, the cost of quarried rock could be around $120 per cubic metre in place. The cost of bank protection would depend on the height of bank or volume of rock required for the slope and apron. These costs could range from $200 per metre of bank to $1000 per metre of bank depending on bank height. Although very expensive, this form of protection can be expected to require very little maintenance even under severe attack. Some cost savings may be achieved by substituting other armouring materials. Gabions installed by a contractor cost in the order of $150 per cubic metre plus the cost of the rock. Since this is very manual labour intensive, costs may be reduced if the owner undertakes much of the work and finds a very economical source of 4" to 8" cobbles.

Choosing the Right Materials

The very best materials to use for armour riprap are broken limestone, dolomite, or quartzite because of their high density and resistance to weathering. These are available from most quarries and consist of roughly broken or blasted rock. The rough angular surfaces and the variety of sizes help the rocks fit tightly together to form a dense barrier.

In some cases, the cost of quarried rock may be prohibitive and you may want to consider some less expensive substitutes.

- Fieldstone may be available locally and can be inexpensive. Although most fieldstone may not be large enough to withstand very high erosive attack, it can be used for low to moderate protection. The main objection to using fieldstone is the rounded shape, which rolls and slides easily in any wave action when submerged. This type of rock is not recommended in most cases.
- If only small (3" to 6" rounded) fieldstone rock is available, gabion baskets can be used.
- Using large pieces of broken concrete (with exposed steel removed) is another possibility Concrete poured into block shaped pieces is excellent, although expensive.
- Sandstone or flagstone may be substituted as well, however, this rock is not as durable as quarried rock when exposed to weather or water. The normal design procedure is to increase the size requirements and volumes by at least 30% to all for size and strength deterioration over time.

Retaining walls in various forms and materials have had success in Alberta, but they can be at least expensive as Method 3. In addition, repairs of these structures can be very difficult and expensive. Professional assistance is recommended.

Although only your imagination and ingenuity limit the scope of suitable substitutes, common sense is essential. Materials that **cannot** be used include:
- Broken asphalt is not dense enough and it is toxic to fish.
- Rubble from the demolition of buildings due to the public safety hazard.
- Junk such as washing machines, refrigerators, bedsprings and car bodies due to a source of toxicity and public safety hazards.

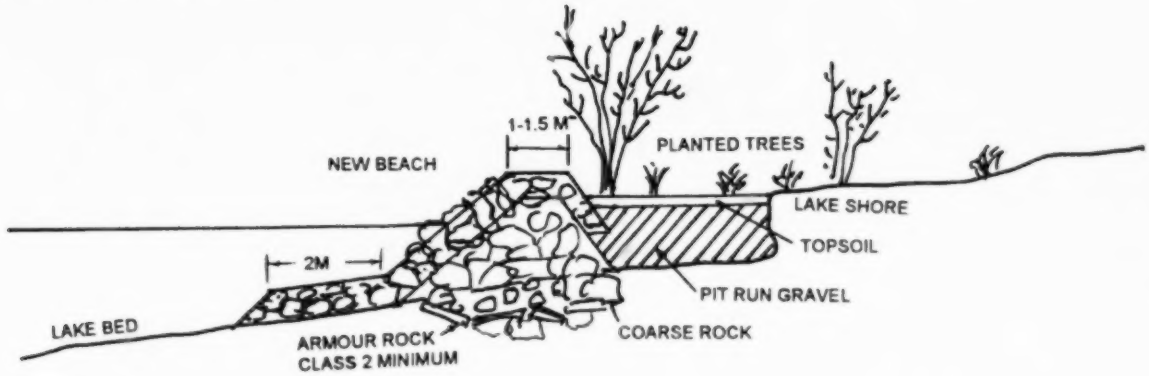
Placing the armour material
The largest, heaviest rocks should be placed along the bottom of the slope. If the rocks protect only the lower portion of the slope, vegetation should be planted in the upper exposed area. This will prevent rainfall from creating riffles or small gullies (1-10 cm or up to 50 cm wide) on an exposed slope

METHOD 4
RE-ESTABLISHING A WASHED OUT SHORELINE....

This situation takes place when a significant amount of shoreline has been eroded and the owners wish to re-establish the shoreline to some previous location that is, currently underwater. The depth of water at which the shore is to be re-established and the influence this work will have on neighbouring properties will limit this approach. Since the Crown under the Public Lands Act may claim all land under water, this option is best discussed with a representative from Alberta Public Lands regardless of land title documents or perceived ownership of the lake bed. This initial consultation is best done prior to any commitment of time or money. The regional offices of the Public Lands Division may be found at:
http://www2.gov.ab.ca/home/Programs_and_Services/dsp_PS.cfm?PS=8201

Conceptually, this method resembles Method 3 on the face of the bank, but with infilling features behind (land side) of the bank. The desired location of a re-established shoreline may be laid out on a drawing or staked in the field. Show the outer edge (water side) of the bank and the majority of the embankment will be about 2 metres back from this line, allowing at least a 3:1 slope of the outer bank. This lakeward location will probably have a rocky, sandy or silty bed material. With a rocky or sandy bed, there will be little settlement of the embankment. However

with a silty bed material, settlement is possible and the depth of the silt should be tested prior to any commitment to build.



The embankment begins with the placement of strong durable material just behind the planned shoreline. The first layer of supporting rock or other durable material may be of lesser quality as it only supports the upper material, which will resist the wave action. The lower material may be made up from broken concrete pieces (exposed steel removed) or other rock material (even rounded cobbles of varying sizes). Do not be surprised if some of this material sinks into the lake bed and out of sight. Settlement of the entire fill may occur at any time or gradually over a period of years. This is the purpose of this base fill material. Once the base course has been filled to just below the existing lake level, the armour protection of the lakeward slope may be added. This is done as described in Method 3. The top width of the newly established bank should be at least 1.5 m and finished in such a manner that there are no safety hazards present.

To fill in the area between the re-established bank and the eroded bank, pit run gravel may be used. The level of this cavity should be filled almost to the level of the current shoreline. The pit run gravel may then be covered with a layer of topsoil and seeded to grass. The planting of shrubs and trees is encouraged along the new shoreline and especially behind the new shoreline in the pit run gravel.

WINTER ICE PROBLEMS...some notes

Anyone on a Canadian shoreline cannot escape the problem of winter ice and more specifically spring break up on any lake. During breakup, the ice near the shore melts first, leaving an open stretch of water between the shore and the main ice pack out in the lake. When the wind blows this massive ice pack moves about freely, although not far. The effect can be devastating as the ice crushes into the opposite shore, destroying everything in its path.

Wind speed, direction and temperature at the time of breakup are major factors in the destructive power of an ice mass. If the temperatures are cold, the crushing strength of ice is quite high. If the temperatures are much warmer, much of the ice mass is weak and in various stages of disintegration. A weak, moving ice mass will normally crumble upon reaching shallow water or the lake shore and damage is less severe.

To minimize the potential damage due to moving ice masses, remove structures such as docks well inland from the shoreline in the fall. Keep any structures including dwellings as far away

from the shoreline as possible. Additional protection is the construction of a suitably armoured bank. However, concrete, steel piles, welded steel pipe and framework supported by rock and even gabions are no guarantee of success. The problem of ice shove does not happen every year, but often enough to cause great frustration. To a large degree the problem can only be managed, never solved.

In the event that an ice mass is approaching a building, the only possible management option would be to allow heavy equipment (loader, bulldozer etc.) to remove the ice as it is pushed up on shore. Normally there is little notice of this event and immediate action is required if the structure is to be saved.

APPENDIX 1

THE ALBERTA ENVIRONMENT WATER ACT APROVAL APPLICATION

An application for an approval consists of:

- The application form itself, containing - name and address of applicant; - legal description of the location of the proposed project and other related information
- Plans, reports, specifications and other supporting data explaining why the project is needed. The advice and assistance of a Professional Engineer and/or Professional Biologist is highly recommended. This information is required to evaluate the effect of the project on the water body and adjacent land parcels.
- A large or complex project may require a report prepared by a Professional Consultant. Contact the regional office for advice in this matter.

APPLICATION REVIEW

Staff from the Regional Water Management team or administration will review the completed application, including plans. Among the points examined are:

- The ownership of the land involved and consents of neighbouring landowners. If the works involve other parties the applicant must consult with their neighbours and obtain the required consents;
- The effect of the proposed project on other landowners, the aquatic habitat, the water resource itself, as well as other projects;
- Additional information, if required;
- Referral to other government departments for concerns including Public Lands Division, and Fish and Wildlife Division of Sustainable Resource Development;
- Referral to other authorities - municipal governments, drainage and irrigation districts, Water Act License holders and others that may have concerns;
- Public notice requirements:

Application forms, information and regional office locations are available at:
http://www.gov.ab.ca/env/water/legislation/index.html

For further technical information, contact the River Engineering Branch at (780) 427-6280 or by email through **Bob.Quazi@gov.ab.ca**. The contact address is River Engineering Branch, 9th floor 9820 – 106 St. Edmonton, Alberta T5K 2J6.

APPENDIX 2...Additional Information

ESTABLISHING VEGETATION

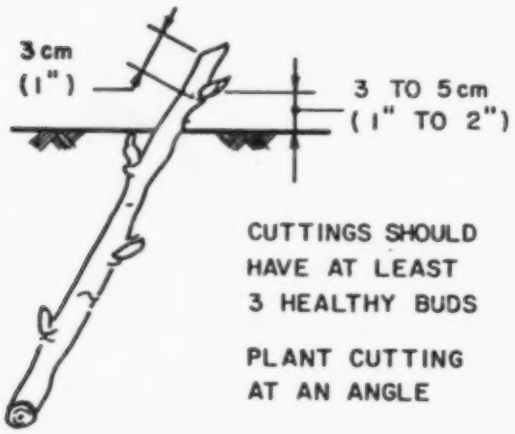
When it comes to revegetating a shoreline, trees and shrubs (bushes) are preferable as their root systems stabilize the soil, offering greater protection. Grasses should only be established where trees and shrubs are considered aesthetically unacceptable. Information on native plant revegetation may be obtained from the Alberta Department of Agriculture, Food and Rural Development at: http://www.agric.gov.ab.ca/publiclands/nprg/col_index.html.

Along the highways and other areas that require a fast, strong ground cover, a mixture of clover and alfalfa is used extensively. The clover, which develops quickly, has a dense root system near the surface. The slower growing alfalfa has a deep root system.

However for a lake lot, Dogwoods are good shrubs for protection, while the best trees are cottonwoods and willows (other trees require seedlings). These items can be planted as cuttings and will grow relatively fast. You can get cuttings from a nursery or you can take them from plants in your area during the spring, before the leaves come out. To do this, take the cuttings from the latest growth - the new wood that grew during the previous season. The cuttings should be from 25 to 40 centimetres long (10 to 15 inches), and from one to one and one half centimetres thick (three eights to one half inch). Be sure to use a sharp knife or pruning shears so that you don't bruise the bark.

Each cutting should have at least three healthy buds on it. Since the ends may dry out, the cuts should be at least three centimetres (one inch) away from the highest and lowest buds. Keep the cuttings moist and plant them as soon as possible.

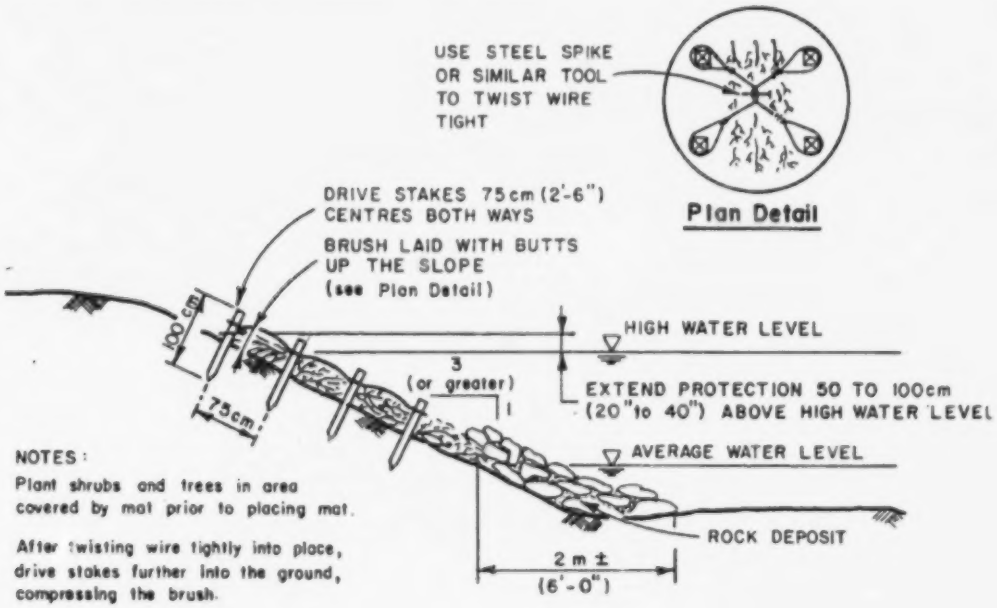
Being careful not to injure the buds, plant the cuttings with the buds pointing up. The topmost bud should be three to five centimetres (one to two inches) above the ground. Space the cuttings about 60 centimetres (two feet) apart in staggered rows.



PROTECTING THE VEGETATION

The new plantings will initially have to be protected from wave attack. Immediately after planting, cover the area with five to 10 centimetres (two to four inches) of mulch. Straw or hay, applied at a rate of 50 kg per 100 square metres (or 100 lbs. per 1000 square feet), is commonly used. To hold the mulch in place, cover it with some type of netting. Make sure the mesh is the right size to retain the type of mulch you are using and anchor the net securely to the slope. A brush mat (as shown in the diagram below) will serve the same purpose.

In some cases, brush mats may be used alone. Although they eventually deteriorate, they allow eroded areas time to restabilize through natural vegetation re-establishment. They encourage vegetation growth (whether planted or naturally occurring) both by protecting plants from wave attack and by encouraging siltation in the voids.


USE STEEL SPIKE OR SIMILAR TOOL TO TWIST WIRE TIGHT
Plan Detail
DRIVE STAKES 75cm (2'-6") CENTRES BOTH WAYS
BRUSH LAID WITH BUTTS UP THE SLOPE (see Plan Detail)
100cm
75cm
3
(or greater)
1
HIGH WATER LEVEL
EXTEND PROTECTION 50 TO 100cm (20" to 40") ABOVE HIGH WATER LEVEL
AVERAGE WATER LEVEL
ROCK DEPOSIT
2 m ±
(6'-0")
NOTES:
Plant shrubs and trees in area covered by mat prior to placing mat.
After twisting wire tightly into place, drive stakes further into the ground, compressing the brush.

Any comments, questions or suggestions regarding the content of this document may be directed to:

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Northern Region
Regional Services
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